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Marc Schmid

Rare Earths in the Trade Dispute Between the US and China: A Déjà Vu

The trade dispute between the US and China has reached a point where export restrictions on rare earths have become a possible means for sanction. This contribution provides a succinct analysis of the current dependency of the US on rare earths from China and draws parallels to the events during the rare earth crisis of 2010 and 2011, which was caused by geopolitical tensions between Japan and China. Respective risks associated with restrictions on the trade of rare earths are considered. Findings suggest that Europe could be affected as well and should be better prepared to mitigate supply disruptions in rare earth trade. Potential mitigation strategies and consequences of the current developments for Europe are also discussed.

The trade dispute between the US and China has been escalating in the course of this year. The US government raised tariffs on Chinese goods valued at 200 billion US dollars from 10% to 25% in May 2019.¹ China reacted by imposing retaliatory tariffs on imports from the US. The initial list from 2018 included goods valued at 50 billion dollars and was extended to goods worth another 60 billion dollars in June 2019. Import tariffs on US products worth 110 billion dollars are now in place, so that almost all exports from the US to China have become subject to import tariffs.² Due to the US trade deficit, which amounted to 420 billion dollars in 2018, China cannot catch up with the amount of goods that are subject to tariffs. China simply imports far less from the US than vice versa.³

The trade dispute reaches rare earths

While there were first signs of rapprochement between the US and China in the trade dispute in October 2019, China also made clear that it might seriously consider using its market power in rare earth production and the US dependency on this as a leverage in the trade dispute.

President Xi's visit to JL Mag, a major producer of rare earth-based permanent magnets, in May 2019 exacerbated these fears.⁴ China's deputy Commerce Minister Wang Shouwen stressed: "If some countries use China's rare earth metals to produce products to contain China's development, this is unacceptable by standards of both minds and hearts".⁵ The Chinese National Development and Reform Commission (NDRC) announced its intention to strengthen its control on the export of rare earths.⁶ Several newspapers, which are close to the communist party, also commented that the

1 Reuters: Factbox: Tariff wars – duties imposed by Trump and U.S. trading partners, 6 May 2019, available at <https://www.reuters.com/article/us-usa-trade-tariffs-factbox/factbox-tariff-wars-duties-imposed-by-trump-and-u-s-trading-partners-idUSKCN1SB0SA>.

2 N. Lung, X. Pi: China Tariff Retaliation Kicks In as Trade War Ratchets Up, Bloomberg, 31 May 2019, available at <https://www.bloomberg.com/news/articles/2019-05-31/china-tariff-retaliation-kicks-in-as-trade-war-ratchets-up>.

3 United States Census Bureau: Trade in Goods with China, 2019, available at <https://www.census.gov/foreign-trade/balance/c5700.html>.

4 S. Zheng: China will not rule out using rare earth exports as leverage in trade war with US, South China Morning Post, 29 May 2019, available at <https://www.scmp.com/news/china/diplomacy/article/3012199/china-will-not-rule-out-using-rare-earth-exports-leverage>.

5 C. Bodeen: China blames US for trade dispute, says it won't back down, The Washington Post, 2 June 2019, available at https://www.washingtonpost.com/world/asia_pacific/china-blames-us-for-trade-dispute-unacceptable-demands/2019/06/02/291bdbe4-84f4-11e9-b585-e36b16a531aa_story.html?noredirect=on&utm_term=.0fcd9179fbd1.

6 Reuters: China to consider strengthening controls on rare earth exports: NDRC, 4 June 2019, available at <https://www.reuters.com/article/us-china-trade-rareearths/china-to-consider-strengthening-controls-on-rare-earth-exports-ndrc-idUSKCN1T5209>.

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Chinese government is seriously considering blocking rare earth exports to the US.⁷

Relevance of rare earths

Rare earths are a group of 17 elements with similar characteristics. They comprise the group of lanthanides plus the elements scandium and yttrium. They are usually categorised as light rare earth elements and heavy rare earth elements with the latter being produced in smaller amounts (due to lesser concentration in the earth's crust) and traded at higher prices. The major application of rare earths is in neodymium-iron-boron (NdFeB) permanent magnets.

Applications of rare earths

As can be seen in Table 1, about one-third of total rare earth mine output is used for the production of permanent magnets. Rare earths have become critical elements for modern technologies such as wind turbines, air conditioners and many household appliances.⁸ The main driver of the expected increase in demand, however, will be electromobility. Recent estimates show that more than 90% of all electric vehicles sold worldwide are equipped with electric drives that use NdFeB permanent magnets, making it, by far, the dominant technology.⁹ In addition, hybrid electric vehicles often use nickel-metal hydride (NiMH) batteries that contain rare earths for energy storage. Such metal alloys are another important application of rare earths.

Large amounts of rare earths are also used as catalysts for petroleum refinery in the oil industry as rare earths improve catalytic processes. Further applications include polishing

Table 1
Applications of rare earths, 2017

Major applications	Market share in %	Products
Permanent magnets	30	Electric vehicles, wind turbines, hard disk drives
Metal alloys	18	Batteries, hydrogen absorption alloys
Catalysts	18	Fluid catalytic cracking, automotive catalysts
Polishing	14	Polishing powders for monitors, optics
Glass	6	UV-protection, laser applications
Ceramics	5	Ceramic capacitors, dental ceramics
Phosphors	4	Energy-efficient lighting (e.g. LEDs), displays
Others	5	Fertilisers, etc.

Source: Own illustration, market shares based on estimates by D.J. Kingsnorth: The Rare Earths Market in 2018. Driven by e-Mobility. Industrial Minerals Company of Australia (IMCOA), Kalgoorlie 2018, Curtin University.

powder for surface treatment, and phosphors that allow energy efficient lighting, e.g. through LEDs, found in smartphones, laptop displays and flat-screen TVs. Rare earths are also extremely important to the US military.

At the same time, various studies have recently found that most rare earth elements are in critically short supply.¹⁰ The critical nature of rare earths can be explained by the market development in the last decades and the resulting current market structure.

Market of rare earths

China entered the rare earth market in the mid-1980s, at a time when the US was the major producer (see Figure 1). But China soon caught up and became the production leader for rare earths. Its heavily state-supported strategy was aimed at dominating the global rare earth industry.¹¹

US production could not keep up with China's political measures, cheap labour costs and low environmental protection standards. The environmental burdens and damag-

7 Global Times: China indicates it may use rare earths as weapon in trade war, 28 May 2019, available at <http://www.globaltimes.cn/content/1152119.shtml>; Hu Xijin, editor-in-chief of the Chinese newspaper Global Times, on Twitter: "I saw some people still don't believe China could restrict rare earth exports to the US, deeming the move will hurt China as well. They just don't understand China, including how information disclosure works in China.", available at https://twitter.com/HuXijin_GT/status/1134131332911489025; see also B. Blanchard, M. Martina, T. Daly: China ready to hit back at U.S. with rare earths: newspapers, Reuters, 29 May 2019, available at <https://www.reuters.com/article/us-usa-trade-china-rareearth/china-ready-to-hit-back-at-u-s-with-rare-earths-ruling-party-newspaper-idUSKCN1SZ07V>.

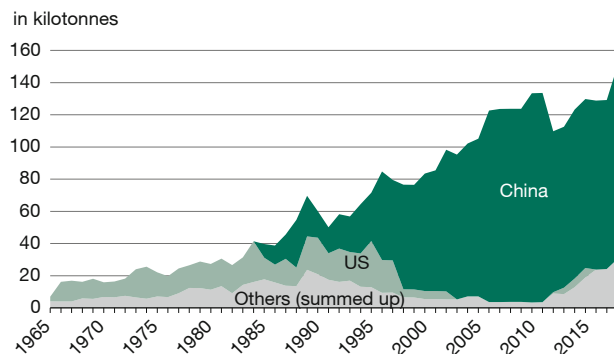
8 Critical raw materials are of high relevance for future technologies like the production of renewable energies. Typically, production amounts are relatively small in comparison to those of minerals like copper and aluminium and prices are often fluctuating. At the same time, there is a high market concentration on the supply side with only few producing countries and companies. Criticality consequently primarily refers to temporary shortages and bottlenecks on the supply side and not to depletion of reserves; see also T.E. Graedel, E.M. Harper, N.T. Nassar, B.K. Reck: On the materials basis of modern society, in: Proceedings of the National Academy of Sciences, Vol. 112, No. 20, 2015, pp. 6295-6300.

9 Adamas Intelligence: Spotlight on Dysprosium: Revving up for rising demand, 26 April 2018, available at <https://www.adamasintel.com/spotlight-on-dysprosium/>.

10 U.S. Government Accountability Office (GAO): Rare Earth Materials: Developing a Comprehensive Approach Could Help DOD Better Manage National Security Risks in the Supply Chain, Report to Congressional Committees No. GAO-16-161, 2016, available at <https://www.gao.gov/assets/680/675165.pdf>.

11 Deng Xiaoping famously said in 1992: "The Middle East has its oil, China has its Rare Earths", freely quoted in K. Bradsher: China Tightens Grip on Rare Minerals, The New York Times, 31 August 2009, available at <http://www.nytimes.com/2009/09/01/business/global/01minerals.html>.

Figure 1
Development of the production market of rare earth



Source: Own illustration, based on data by USGS: Rare Earths, U.S. Geological Survey, Mineral Commodity Summaries, available at http://minerals.usgs.gov/minerals/pubs/commodity/rare_earth/, in rare earth oxide equivalent content.

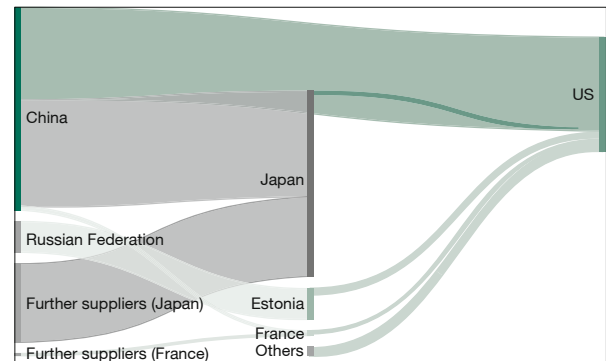
es associated with the extraction, separation and processing of rare earths include those caused by the radioactive elements uranium and thorium as well as various acids. The necessary environmental protection would have been costly for US rare earth mines. Price competitiveness was hard to achieve due to low to non-existent Chinese environmental standards; as a result, the US finally stopped its rare earth production in 2002.

China's market power peaked in 2010/2011 when it reached a market share of around 97% of all rare earth mineral production. Outside of China, there were almost no other producers left. Since then, new rare earth mine projects have been developed worldwide, causing China's market share to decrease slightly to around 70-80%. However, China's overall leadership position in the rare earth market remains uncontested. Over the past few decades, China has also become a technological leader in the separation and processing of rare earths. Almost all processing of rare earth ores mined in the world takes place in China. Today, China accounts for about 90% of rare earth oxide production.¹² Dependency reaches even further down the value chain as China also dominates the production of all major applications of rare earths, including high-performance magnet production. China's share in the global NdFeB magnet market has reached more than 80%.¹³

¹² Data by Adamas Intelligence as quoted in Y.-H. Law: Radioactive waste standoff could slash high tech's supply of rare earth elements, *Science*, 1 April 2019, available at <https://www.sciencemag.org/news/2019/04/radioactive-waste-standoff-could-slash-high-tech-s-supply-rare-earth-elements>.

¹³ X. Du, T.E. Graedel: Uncovering the end uses of rare earth elements, in: *Science of the Total Environment*, Vol. 461-462, 2013, pp. 781-784.

Figure 2
Sources of US rare earth imports, 2018



Source: Own illustration, calculation of trade flows based on data by USGS: Rare Earths, U.S. Geological Survey, Mineral Commodity Summaries, February 2019, available at <https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-raree.pdf>; UN Comtrade, available at <https://comtrade.un.org/data/>, only trade streams with direct connection between China and US included; diagram created using SankeyMATIC.

The US dependency on rare earths from China

Outside of China, the US is the second largest consumer of rare earths in the world behind Japan (see Figure 2). In 2018, the US imported a total of 18,500 tonnes, amounting to 165 million dollars.¹⁴ The market for rare earths is relatively small: total value and import amounts are negligible and economically insignificant to the US. The actual relevance of rare earths is instead based on their applications and the added value in the final products.

About 60% of US rare earth imports are used as catalysts for petroleum refining, making it the country's major consumer of rare earths.¹⁵ The US oil industry is the largest petroleum producer worldwide and extremely important to the US economy.¹⁶ The industry is highly dependent on rare earths for fluid catalytic cracking as their substitution leads to inferior results.¹⁷ Besides the oil industry, the US military also depends on rare earths. Many of the most advanced US weapon systems, including smart bombs, unmanned drones, cruise missiles, laser targeting, radar systems and

¹⁴ Calculation based on data by UN Comtrade, 2019, available at <https://comtrade.un.org/data/>.

¹⁵ USGS: Rare Earths, U.S. Geological Survey, Mineral Commodity Summaries, February 2019, available at <https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-raree.pdf>.

¹⁶ EIA: Total Petroleum and Other Liquids Production – 2018, available at <https://www.eia.gov/beta/international/>.

¹⁷ A. Nieto, K. Guelly, A. Kleit: Addressing criticality for rare earth elements in petroleum refining: The key supply factors approach, in: *Resources Policy*, Vol. 38, No. 4, 2013, pp. 496-503.

the Joint Strike Fighter programme rely on rare earths.¹⁸ Against this background, the US Department of Defense (DoD) stated that “[r]eliable access to the necessary material [...] is a bedrock requirement for DOD”.¹⁹

The specific rare earth dependency of the US is also a result of its supply structure: about 80% of US rare earth imports come from China. Other relevant suppliers are Estonia, Japan and France. Whereas Estonia procures its rare earths completely from the Russian Federation, Japan and France are only secondary processing links that have no domestic mine production. Both countries import more than half of total demand directly from China as well. As a result, the US dependency on a stable supply of rare earths from China is even higher than the 80% import share suggests (see Figure 2).

The US government is aware of this problem. Already in 2018, rare earths played a critical role when tariffs were introduced. The first draft of the list of commodities to be taxed by the US included rare earths.²⁰ This draft, with a volume of 200 billion dollars, was subject to minor changes as stakeholders were able to comment on the tariff lines. It is of note that those modifications led to the exclusion of rare earths from the final list and they consequently were not subject to import tariffs imposed by the US government in September 2018.²¹ This remarkable decision shows that the US considers itself to be highly dependent on rare earths and certain other critical raw materials.

Déjà vu: The role of rare earth in the conflict between China and Japan in 2010

The current situation resembles the first rare earth crisis in 2010 and 2011. Over a period of years, China had reduced its export quota on rare earths. In combination with its export tariffs, China had used its market power to strengthen its domestic industry and to disadvantage companies

worldwide.²² This situation worsened in 2010. Geopolitical tensions between Japan and China were sparked when a Chinese fisherman was arrested near the Senkaku Islands, a territory where both countries claimed ownership. In retaliation, China blocked the export of rare earths to Japan for several weeks.²³

The supply disruption led to insecurity in the market. Prices exploded more than tenfold. Many companies worldwide who were using rare earths were unsure how long they could sustain production. Japan's overall industry structure, which included leading firms in the fields of electric vehicles, flat panels and consumer electronics as well as future technologies like robots, made the country highly vulnerable to supply disruptions.

As the free flow of rare earths was endangered, the major consumers – Japan, the US and the EU – filed a complaint with the World Trade Organization (WTO). The decision of the WTO panel in 2014 made clear that China's export quota was inconsistent with WTO regulations.²⁴ Consequently, China had to cease its export quotas in 2015, four years after the rare earth crisis.

In the meantime, markets remained precarious. Global value chains shifted to China as companies that heavily relied on a secure rare earth supply relocated their production plants to China. This was considered part of China's motivation to block rare earth exports: “China is eyeing the valuable know-how foreign companies will bring into joint ventures with Chinese firms to gain access to rare earths,”²⁵ was the widespread opinion. Japan's expertise in NdFeB magnet production was of particular interest to China. Japan, once by far the most important producer of NdFeB magnets with market shares of 50% or more, had lost its position and today accounts for less than 20% of global NdFeB magnet production.²⁶ The rare earth crisis accelerated this development as the remaining NdFeB magnet production in Japan was hit hard by the supply disruptions and renowned Japanese companies relocated their production sites to China.

18 V.B. Grasso: Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress, CRS Report No. R41744, 2013, Congressional Research Service, available at <https://fas.org/sgp/crs/natsec/R41744.pdf>.

19 GAO: Rare Earth Materials: Developing a Comprehensive Approach Could Help DOD Better Manage National Security Risks in the Supply Chain, Report to Congressional Committees, February 2016, United States Government Accountability Office, GAO-16-161, available at <https://www.gao.gov/assets/680/675165.pdf>.

20 USTR: Request for Comments Concerning Proposed Modification of Action Pursuant to Section 301: China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation, 2018, Office of the United States Trade Representative, USTR-2018-0026, available at https://ustr.gov/sites/default/files/301/2018-0026%20China%20FRN%207-10-2018_0.pdf.

21 USTR: Tariff List – September 17, 2018, Office of the United States Trade Representative, available at <https://ustr.gov/sites/default/files/enforcement/301Investigations/Tariff%20List-09.17.18.pdf>.

22 W.M. Morrison, R. Tang: China's Rare Earth Industry and Export Regime: Economic and Trade Implications for the United States, CRS Report for Congress No. 7-5700, Congressional Research Service, April 2012, available at <https://fas.org/sgp/crs/row/R42510.pdf>.

23 K. Bradsher: Amid Tension, China Blocks Vital Exports to Japan, The New York Times, 22 September 2010, available at <http://www.nytimes.com/2010/09/23/business/global/23rare.html>.

24 World Trade Organization: Reports of the Panel: China – Measures Related to the Exportation of Rare Earths, Tungsten, and Molybdenum, WT/DS431/R, WT/DS432/R, WT/DS433/R, 26 March 2014.

25 Y. Inoue, J. Gordon: Analysis: Japanese rare earth consumers set up shop in China, Reuters, 12 August 2011, available at <https://www.reuters.com/article/us-rareearth-japan-idUSTRE77B3TH20110812>.

26 X. Du, T.E. Graedel, op. cit.

Consequently, the government of Japan budgeted 650 million dollars to secure a supply of strategically relevant raw materials for 2011. The highest amount, 240 million dollars, was allocated to the development of rare earths abroad. Another 83 million dollars was assigned to examining the potential of deep sea mining to extract rare earths, manganese and nickel.²⁷ Besides the government's investments into new rare earth projects and exploration of unconventional deposits, many Japanese companies increased their stockpiles whereas others tried to recycle or substitute other minerals for rare earths, completely or partially, to reduce or eliminate their dependency on rare earths. However, Japan essentially lost its competitive advantage over China and is still dependent, albeit to a lesser extent, on China's supply of rare earths.

What is at stake for the US and China?

During the first rare earth crisis, the rest of the world became aware of its dependence on China for a stable supply of rare earths. However, the politic response from the US and in Europe remained relatively restrained.²⁸ In contrast, the current US administration has been quite active in addressing supply risks of certain raw materials. Recent assessments have analysed the US' current dependency on imports of rare earths and other important raw materials.²⁹ The US president signed an Executive Order in 2017 intended to develop strategic measures to ensure a stable supply.³⁰ The US Department of Commerce presented its 'Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals' with calls for action to work out recycling processes and substitutes, to establish a supply chain for rare earths outside of China and to access domestic deposits.³¹ Faced with

recent developments, the US DoD is currently seeking funding for domestic rare earth projects to reduce its dependency on imports.³² The US is also in talks with Canada about defense funding for rare earth production and processing facilities; is trying to set up a partnership in Australia for processing of rare earths; and has signed a memorandum of understanding with Greenland to explore Greenland's rare earth deposits.³³

Developing a rare earth project, however, takes up to ten years and requires large investments.³⁴ 'Mountain Pass' in California is one of the few rare earth projects that have started production in recent years. But Mountain Pass does not have sufficient resources of the particularly critical heavy rare earths, mainly producing light rare earth elements. In addition, after a spectacular bankruptcy in 2015, a consortium with participation of a Chinese state company acquired Mountain Pass.³⁵ Since then, its rare earth concentrate is shipped to China where there is an overcapacity for the separation and processing of rare earth. Similar developments occur in many advanced projects. Whereas actual mining seems relatively unproblematic, separation and processing are a major challenge. Rare earth concentrates from mining projects outside of China are typically shipped to China for further processing. New rare earth mine projects outside of China with processing facilities remain years away and are unlikely to have a short-term effect.³⁶ Recently announced plans to build a separation plant in the US will also take time until they reach production stage.³⁷

27 Reuters: FACTBOX-Japan budgets \$650 mln for rare earths, resources, 5 January 2011, available at <https://www.reuters.com/article/japan-china-rareearth/factbox-japan-budgets-650-mln-for-rare-earths-resources-idUSTOE70404220110105>.

28 E. Barteková, R. Kemp: National strategies for securing a stable supply of rare earths in different world regions, in: Resources Policy, Vol. 49, 2016, pp. 153-164.

29 NSTC: Assessment of Critical Minerals: Updated Application of Screening Methodology. A Report by the Subcommittee on Critical and Strategic Mineral Supply Chains, February 2018, Committee on Environment, Natural Resources, and Sustainability, National Science and Technology Council, available at <https://www.whitehouse.gov/wp-content/uploads/2018/02/Assessment-of-Critical-Minerals-Update-2018.pdf>; K.J. Schulz, J.H. DeYoung Jr., R.R. Seal II, D.C. Bradley (eds.): Critical Mineral Resources of the United States – Economic and Environmental Geology and Prospects for Future Supply, Reston 2018, U.S. Geological Survey.

30 The White House: Executive Order on a Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, 20 December 2017, available at <https://www.whitehouse.gov/presidential-actions/presidential-executive-order-federal-strategy-ensure-secure-reliable-supplies-critical-minerals/>.

31 U.S. Department of Commerce: A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, 4 June 2019, available at <https://www.commerce.gov/news/reports/2019/06/federal-strategy-ensure-secure-and-reliable-supplies-critical-minerals>.

32 P. Stewart, A. Shalal: Pentagon seeks funds to reduce U.S. reliance on China's rare earth metals, Reuters, 29 May 2019, available at <https://www.reuters.com/article/us-china-usa-rareearth-pentagon/pentagon-seeks-funds-to-reduce-u-s-reliance-on-chinas-rare-earth-metals-idUSKCN1SZ2C6>.

33 L.M. Lombrana, T. Argitis: U.S. and Canada Discuss Supply of Rare Earths as China Dominates, Bloomberg, 30 September 2019, available at <https://www.bloomberg.com/news/articles/2019-09-30/u-s-and-canada-discuss-supply-of-rare-earths-as-china-dominates>; US Department of State: Joint Statement on U.S.-Greenland MOU and Hyperspectral Survey, 6 June 2019, available at <https://www.state.gov/joint-statement-on-u-s-greenland-mou-and-hyperspectral-survey/>; Reuters: Pentagon in talks with Australia on rare earths plant: official, 27 August 2019, available at <https://www.reuters.com/article/us-usa-rareearth-australia/pentagon-in-talks-with-australia-on-rare-earths-plant-official-idUSKCN1VH1UY>.

34 D.J. Kingsnorth: Der globale Markt der Seltenen Erden – Ein Balanceakt, in: P. Kausch, M. Bertau, J. Gutzmer, J. Matschullat (eds.): Strategische Rohstoffe – Risikoversorgung, Berlin, Heidelberg 2014, Springer Spektrum, pp. 97-121.

35 A. Topf: Mountain Pass sells for \$20.5 million, Mining.Com, 16 June 2017, available at <http://www.mining.com/mountain-pass-sells-20-5-million/>.

36 M. Schmid: Mitigating supply risks through involvement in rare earth projects: Japan's strategies and what the US can learn, in: Resources Policy, Vol. 63, 2019, Article 101457.

37 J. Smyth: Lynas to build rare earths processing plant in the US, Financial Times, 20 May 2019, available at <https://www.ft.com/content/20badb28-7a9d-11e9-81d2-f785092ab560>.

The only real alternative and the main competitor for Chinese rare earth production is the Australian rare earth company Lynas that has close ties to Japan. After the first rare earth crisis, Japan was actively engaged in reducing its dependency on China and invested in rare earth projects worldwide. Lynas was one of these projects. A large share of Lynas' annual production therefore goes to Japan and to other consumers with long-term contracts making it incapable of meeting US demand in the case of supply disruptions.³⁸

The US remains vulnerable as long as there is no alternative rare earth value chain. Most parts of the value chain are missing outside China and in the US in particular.³⁹ The US is not only dependent on imports of the raw materials, but also on imports of rare earth-based components as there is almost no rare earth-related industry remaining in the US. The US military even struggles to abide by the law and avoid the use of alloys from outside the US in their military equipment as domestic production of NdFeB magnets, for example, barely exists anymore.⁴⁰

Substitution of rare earths could help to reduce supply risks along the value chain in the short term. However, rare earths tend to deliver better results than substitutes in most applications. The use of substitutes can therefore become a competitive disadvantage. Similar problems exist with the recycling of rare earths. Recycling quotas remain small as price competitiveness and equal performance of secondary raw material are still not in place. For the moment, the US can only hope that China restrains itself from abusing its market power for political reasons.

In fact, China has its own reasons to think twice about using rare earths in the trade dispute:

1. China's reputation as a reliable supplier is a prerequisite for keeping its market power. A second rare earth crisis, caused by renewed Chinese export restrictions, could give rise to long-term doubts about China's reliability as a producer and supplier. A loss of trust could accelerate new mining projects outside China and motivate consumers worldwide to work on a parallel supply chain, which would ultimately reduce China's market power.

³⁸ M. Schmid, op. cit.

³⁹ United States Government Accountability Office (GAO): Rare Earth Materials: Developing a Comprehensive Approach Could Help DOD Better Manage National Security Risks in the Supply Chain, Report to Congressional Committees No. GAO-16-161, February 2016, available at <https://www.gao.gov/assets/680/675165.pdf>.

⁴⁰ J. Shiffman, A. Shalal-Esa: Exclusive: U.S. waived laws to keep F-35 on track with China-made parts, Reuters, 3 January 2014, available at <https://www.reuters.com/article/us-lockheed-f35/exclusive-u-s-waived-laws-to-keep-f-35-on-track-with-china-made-parts-idUS-BREA020VA20140103>.

2. Price peaks due to supply disruptions would disturb China's fight against illegal mining activities. At the moment, the major competitor to China's regulated rare earth industry is not mining outside of China, but illegal mining activities within the country, which have led to remarkable market relaxation during recent years. Extracting heavy rare earths out of ionic clays has been a common practice in the Southern provinces of China and is acknowledged by the government of the People's Republic of China (PRC).⁴¹ According to different estimations, illegal mining activities account for around 30% of total rare earths production in China. Although these numbers tend to differ slightly in the literature, overall, the scientific community agrees on the general magnitude of illegal mining.⁴² Supply restrictions that lead to price increases would spur illegal production and would counteract China's endeavour to curb these activities, consolidate and fully control its own rare earth industry.

Nevertheless, China is only exposed to minor risks in comparison to the potential damages of an export ban that would hit the US much harder.

Lessons learned for the EU

This is the second time within a decade that the stable supply of rare earths has been put at risk – the first time in 2010 and 2011 during a territorial conflict between China and Japan, and now this current trade dispute between China and the US. History may be repeating itself. During the first rare earth crisis, Paul Krugman commented that China seems to be willing “[...] to wage economic warfare on the slightest provocation”.⁴³

Europe has not been directly involved in either of the two rare earth-related conflicts. However, there might be considerable effects on Europe if rare earths became part of the trade dispute between the US and China. In recent years, the EU has imported about the same amount of rare earths as the US and is among the largest consumers of rare earths. European industries, including the automotive, wind power and industrial drives producers, rely on a stable supply of rare earths. Without being the direct target, Europe

⁴¹ D.J. Packey, D. Kingsnorth: The impact of unregulated ionic clay rare earth mining in China, in: Resources Policy, Vol. 48, 2016, pp. 112-116.

⁴² R.P. Biedermann: China's rare earth sector – between domestic consolidation and global hegemony, in: International Journal of Emerging Markets, Vol. 9, No. 2, 2014, pp. 276-293; D. Schlinkert, K.G. van den Boogaart: The development of the market for rare earth elements: Insights from economic theory, in: Resources Policy, Vol. 46, 2015, pp. 272-280.

⁴³ P. Krugman: Rare and Foolish, The New York Times, 17 October 2010, available at http://www.nytimes.com/2010/10/18/opinion/18krugman.html?_r=0.

could be negatively affected by supply shortages outside of China, which would lead to price increases.

For the moment, the EU and its member states can become proactive, take a strategic position and reduce their exposure to supply risks. Affected companies that need to cope with price and supply risks at first have a wide range of potential strategies to mitigate them.⁴⁴ Some of these strategies can be politically supported including those that can be implemented by both companies and governments. These are:

- Stockpiling rare earths, which enables buffering of supply disruptions through stock removal;
- Direct access to raw material production outside of China, e.g. through direct investments into a rare earth mine or offtake agreements;
- Recycling of rare earths at the end of life and replacing primary raw materials by secondary raw materials, which decreases the dependency on rare earth from China;
- Substitution of rare earths, either partially by increases in material efficiency or completely by switching to a different technology.

Political measures to promote these strategies include government stockpiling, research funding, political partnerships with resource-rich countries and investment protection – to name just a few.

Since the first rare earth crisis, many efforts have already been made to decrease dependency on China. Several criticality studies raised awareness of the supply risks associated with rare earth and other raw materials. The EU has particularly supported R&D activities related to recycling and substitution of rare earths. Further activities and measures such as strategic reactions to trade distortions could become necessary as the technologies that pave the path to a green economy will spur the demand for rare earths.

As rare earths have again become the subject of geostrategic measures, the EU and its member states should seriously consider promoting the development of a parallel supply chain outside China in order to reduce their exposure to related supply risks.

A profound step would be to establish an organisation responsible for securing the supply of critical raw materials, similar to Japan's JOGMEC (Japan Oil, Gas and Metals National Corporation). JOGMEC is an incorporated adminis-

⁴⁴ M. Schmid: Unternehmerische Rohstoffstrategien: Zum Umgang mit kritischen Versorgungssituationen, forthcoming.

trative agency responsible for securing raw material supply through different activities such as financing, exploration, project development and raw material production as well as stockpiling strategic raw materials. The US apparently has tried a similar approach, examining potential investments into rare metal companies with its Overseas Private Investment Corporation (OPIC).⁴⁵ In June 2019, the US government also launched the Energy Resource Governance Initiative (ERGI). To date, nine countries – including Australia, Argentina and Brazil – have joined the initiative, which aims to develop mineral projects to secure and diversify the supply of raw materials on the basis of a 'government to government commitment'.⁴⁶ So far, there are no comparable organisations in Europe. The EU has not directly engaged in mine production yet, and, in contrast to the US, there is currently no rare earth mine production in the EU.

As a global economic powerhouse, strategic actions of the EU could have significant impact on the criticality of rare earths – and could bundle and supplement activities of individual member states. Germany, the EU's largest economy, could give a first indication of such a strategy this winter when the German government will presumably present its revised raw material strategy. The supply of rare earths and critical raw materials in general will be an important part of this. With its revised raw material strategy, Germany has an opportunity to resolve supply risks of critical raw materials that are crucial for future technologies and the overall economic development of the country.

Need for strategies to mitigate supply risks

In the first round of the trade dispute between the US and China, import tariffs were the means of choice. The second round could involve export restrictions and lead to a further escalation. Once again, China seems to be willing to use its dominance in the rare earth market in the trade dispute with the US as the risks that it would face seem to be comparatively small. The negative consequences would hit the US hard, and would also have a negative impact on the EU. Although not directly involved in the conflict, the EU should be proactive, consider whether or not its current strategy meets the potential new challenges and strengthen its capabilities to mitigate impending supply disruptions. Establishing a parallel supply chain of rare earths seems to be the most effective, but also the most challenging strategy for this.

⁴⁵ H. Chowdhury: US government taps UK firm to secure rare metals, The Telegraph, 22 April 2019, available at <https://www.telegraph.co.uk/technology/2019/04/22/us-government-taps-uk-firm-secure-rare-metals/>.

⁴⁶ Reuters: Nine countries join U.S. strategic minerals initiative, 26 September 2019, available at <https://www.reuters.com/article/usa-minerals-china/nine-countries-join-u-s-strategic-minerals-initiative-idUSL2N26G229>.